

(12) UK Patent Application (19) GB (11) 2 382 803 (13) A

(43) Date of A Publication 11.06.2003

(21) Application No 0129420.6

(22) Date of Filing 07.12.2001

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(51) INT CL⁷
B60R 21/16

(52) UK CL (Edition V)
B7B BSBCC BSBCM

(56) Documents Cited
JP 2001294112 A

(58) Field of Search
UK CL (Edition T) B7B BSBCC BSBCM
INT CL⁷ B60R 21/16 21/20
Other: WPI, EPODOC, JAPIO

(54) Abstract Title
Method of folding an airbag

(57) A method of folding an airbag (2) which is connected to a housing (21) which incorporates a gas generator (22) comprises the steps of configuring the airbag (2) so that the main inflatable part of the airbag is in the form of two depending tabs (25, 26). The lower ends of the tabs are gripped by counter-rotating rolling forks (9, 10) located within a cavity (6). The rolling forks roll the tabs into two parallel rolls located within the cavity. Covers (7, 8) are slid across the cavity and the rolling forks are retracted. Plungers then move axially of the thus-formed rolls (30, 31) thus scrunching or randomly folding the rolls. Finally the compressed airbag is driven into the housing.

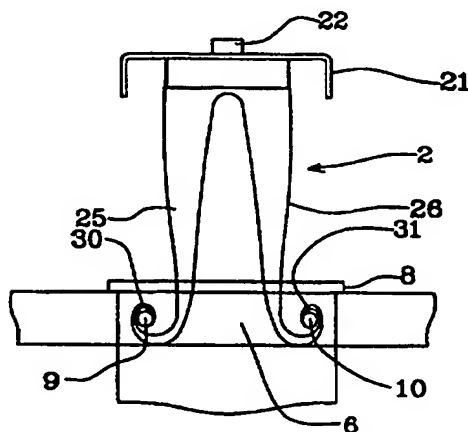


FIG 6

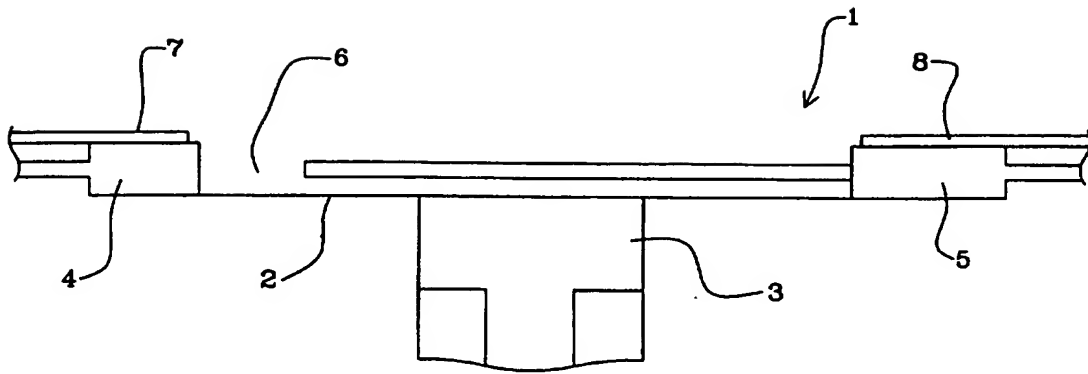


FIG 1

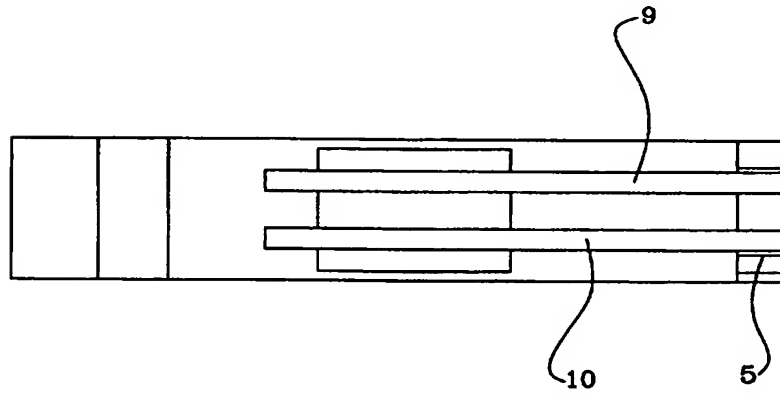


FIG 2

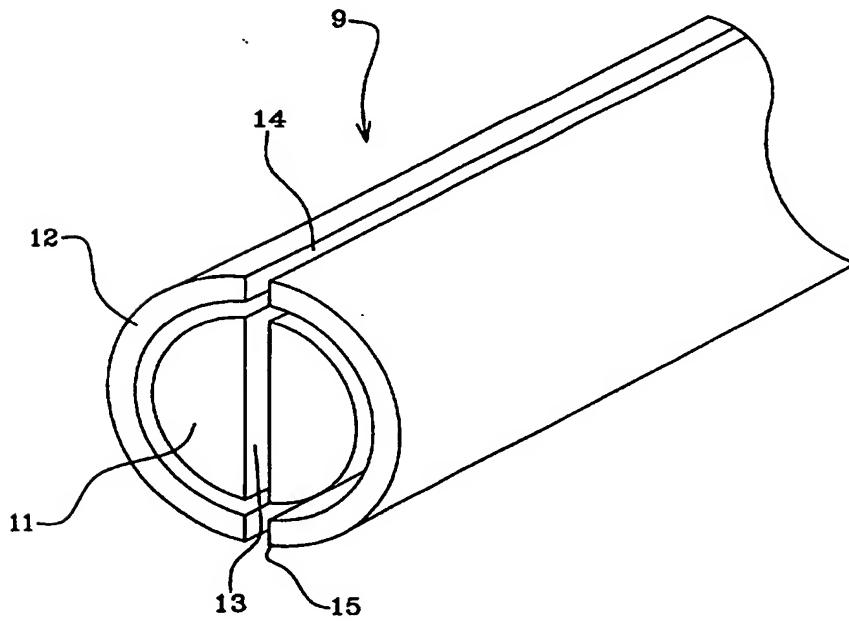


FIG 3

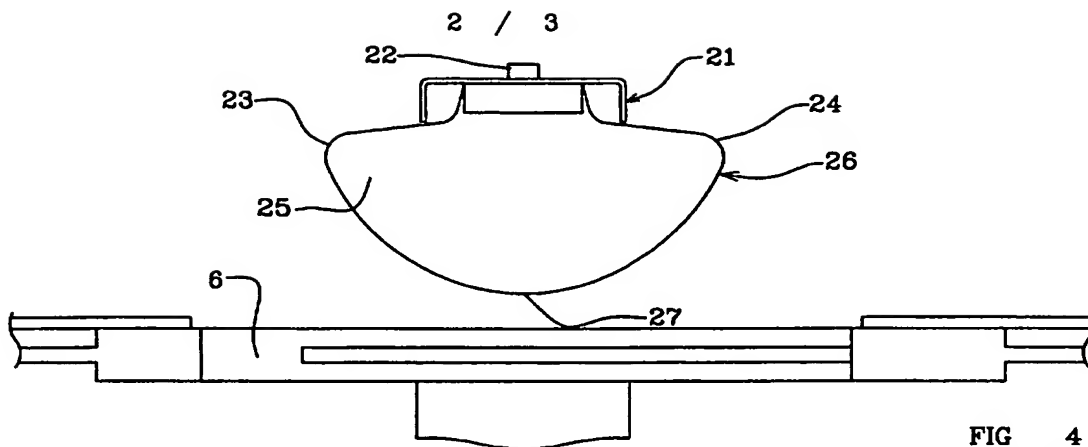


FIG 4

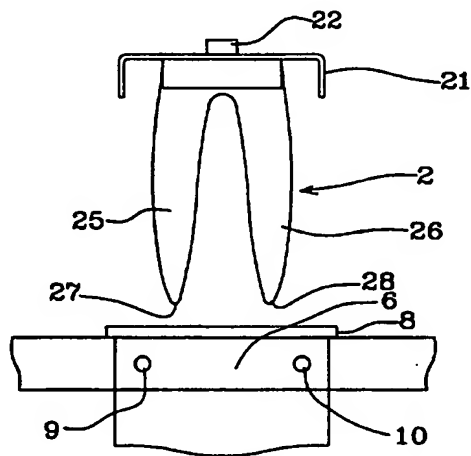


FIG 5

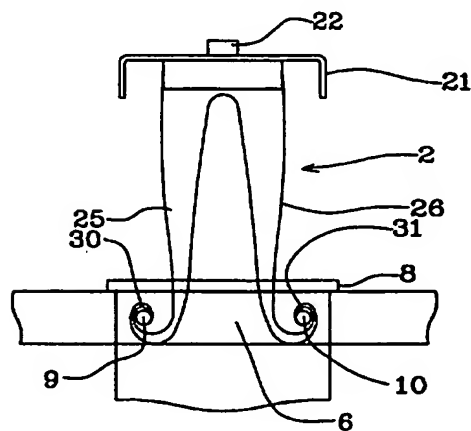


FIG 6

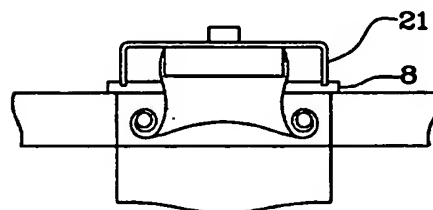


FIG 7

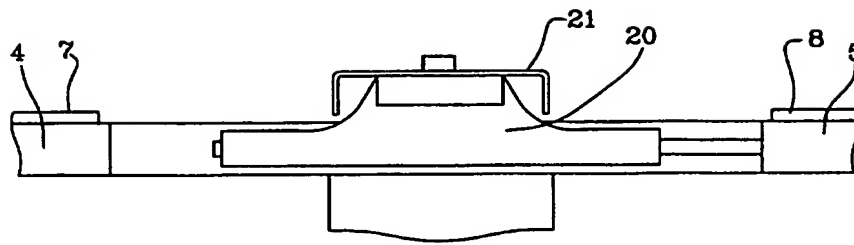


FIG 8

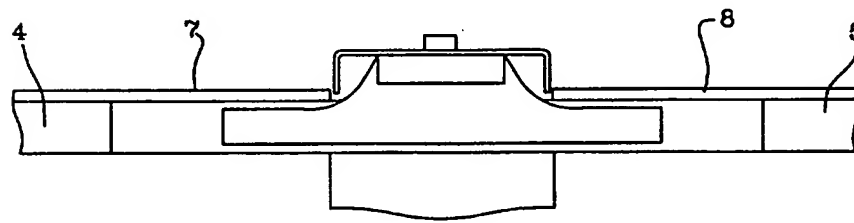


FIG 9

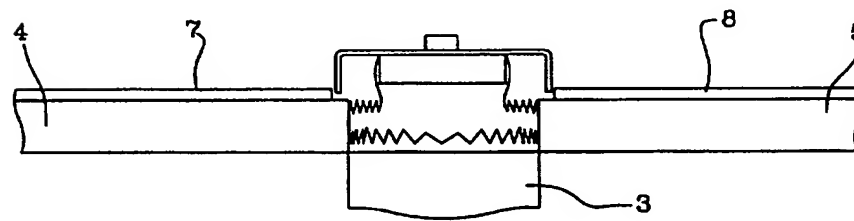


FIG 10

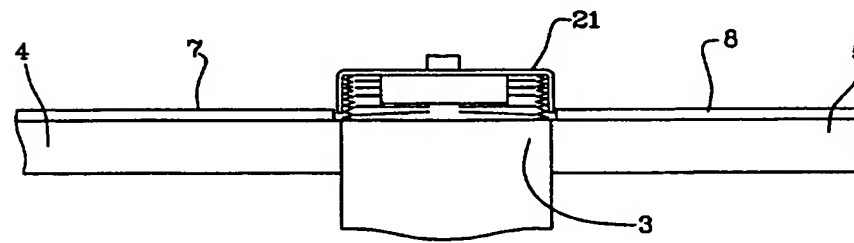


FIG 11

DESCRIPTION OF INVENTION**“IMPROVEMENTS IN OR RELATING TO AN APPARATUS FOR AND METHOD OF FOLDING AN AIR-BAG”**

THE PRESENT INVENTION relates to an apparatus for, and a method of, folding an air-bag, and in particular relates to a method of, and an apparatus for, folding an air-bag for use in protecting a front seat occupant of a motor vehicle, especially for protecting a driver of a motor vehicle.

Many techniques have been proposed previously for the folding of an airbag. The desirable characteristics of a technique for folding an airbag are that the technique should be economically viable, and should give a good consistent deployment characteristic of the airbag when the airbag is inflated.

It has been proposed previously to fold an airbag using simple compression folding, which provides a random folding characteristic. This can be achieved by simply hanging an airbag within an appropriate chamber and moving the sides and base of the chamber physically inwardly so that the airbag becomes crushed or scrunched folded. This technique does have the advantage that there are no close fold-lines, where two adjacent layers of fabric are folded about the same fold-line, which may prevent the flow of gas within the interior of the airbag. However, this technique has been found to have the disadvantage

that airbags which have been folded in this way may not deploy in precisely the intended manner. Part of the airbag, for example, may strike the occupant of the vehicle, who is to be protected by the airbag, under the chin with an upward movement, which can cause injury to the neck of the occupant. This event is more likely to occur if the occupant is not in the expected position within the seat.

The present invention therefore seeks to provide an improved apparatus for and method of folding an airbag.

According to this invention there is provided a method for folding an airbag comprising steps of taking an airbag secured to an airbag housing dimensioned to receive the airbag when folded, configuring the airbag to have two depending tabs, rolling or folding each of the tabs to form a roll or fold having an axis, the axes being substantially parallel, subsequently compressing the rolled or folded tabs axially so that the compressed airbag has a configuration equivalent to that of the interior of the housing, and then driving the compressed airbag into the housing;

In one embodiment the airbag is held in the initial position by a holding device which holds points on the periphery of the airbag

In an alternative embodiment the airbag is held in the initial position by means of an elongate support element. The elongate support element may be a simple support rod.

Conveniently the two depending tabs are rolled in opposed directions, being rolled outwardly from the centre of the airbag.

According to another aspect of this invention there is provided an apparatus for folding an airbag, the apparatus comprising a first arrangement to hold the airbag in a configuration with two depending tabs, the apparatus further comprising a folding table having two parallel rolling or folding mechanisms each adapted to engage one of the said tabs and roll or fold the tab, and a compressing arrangement to compress the rolled or folded tabs thus created and a driving arrangement adapted to drive the compressed airbag into a housing.

Conveniently the compressing mechanism comprises two horizontally moveable plungers, moveable towards each other above a folding surface of the folding table, the plungers being associated with covers, also moveable towards each other, the covers being moveable to a position in which a cavity is defined between the covers and the table, the plungers being moveable into the cavity.

Advantageously the driving arrangement comprises a plunger provided in the table, and moveable vertically from an initial position in which the upper surface of the plunger is flush with the folding surface of the table.

Conveniently the table has two rolling mechanisms, each rolling mechanism being in the form of a rolling fork comprising an inner generally cylindrical or tubular element received rotatably within an outer tubular element, the inner element and the outer element each having an axial slot, the elements being movable rotationally relative to each other, and being moveable rotationally together.

According to another aspect of this invention there is provided a rolling fork, the rolling fork comprising an inner generally cylindrical or tubular,

element received rotatably within an outer tubular element, the inner element and the outer element each having an axial slot, the elements being movable rotationally relative to each other, and being moveable rotationally together.

Preferably one element is freely rotatable and the other element is rotationally driven.

Conveniently the inner element is a slotted rod.

In order that the invention may be more readily understood, and so that further features thereof may be appreciated, the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a sectional view of part of a folding table for use in folding an airbag in accordance with the method of the present invention

FIGURE 2 is a top plan view of the folding table as shown in Figure 1;

FIGURE 3 is a end view of a rolling fork as shown in Figure 2;

FIGURE 4 is a side-view, corresponding to Figure 1, showing the folding table prepared for use in folding an airbag;

FIGURE 5 is an end-view of the table of Figure 4;

FIGURE 6 is a view corresponding to Figure 5 showing a later stage during the folding of an airbag;

FIGURE 7 is a view corresponding to Figure 6 showing a later stage in the folding of an airbag;

FIGURE 8 is a side-view of the arrangement of Figure 7;

FIGURE 9 is a view corresponding to Figure 8 at a later stage in the folding process;

FIGURE 10 is a view corresponding to Figure 9 at a later stage in the folding process; and

FIGURE 11 is a view corresponding to Figure 10 at a final stage in the folding process

Referring initially to Figure 1 a folding table 1 for use in folding an airbag comprises a table presenting a substantially horizontal upper folding surface 2. A central part of the table is constituted by a vertically moveable plunger 3. The plunger has a cross-sectional area and shape corresponding to the area and shape of a housing for containing an airbag, as it will become clear from the following description. The plunger 3 is initially in a position where the upper surface of the plunger is flush with the upper folding surface of the table. The plunger 3 may, however, move upwardly from this initial position in response to actuation of an appropriate drive mechanism, which is not shown.

Mounted for horizontal sliding movement across the top of the folding surface of the table are two laterally moveable plungers 4 and 5. The plungers are located at each side of a cavity 6. The plungers are shown in an initial retract position, but the plungers may move inwardly towards each other under

the action of an appropriate drive mechanism, which is not shown. The plunger 5, as will become clear from the following description, may have bores which extend through the main body of the plunger or may be a split plunger constituted by two plunger elements which moves in synchronism .

Mounted above the horizontally movable plunger elements are slidably mounted cover plates 7, 8. The cover plates 7, 8 are also associated with the drive mechanism which can be actuated to move the cover plates inwardly towards each other from the illustrated initial retracted position, to a position in which the cover plates extend above almost all of the cavity 6.

Referring now to Figure 2, extending through the bores in the plunger 5, or, if the plunger is split, between the two parts of the horizontally moveable plunger 5, are two elongate rolling forks 9, 10. The rolling forks extend across the cavity 6 extending above the vertically moveable plunger 3. The rolling forks are parallel and spaced apart by a short distance. The rolling forks, as will be described, may be rotated, and also may be retracted from the cavity 6 so that the rolling forks are retracted to a position in which the rolling forks no longer extend into the cavity 6.

As will become clear from following description the rolling forks are each adapted to engage an edge part of an airbag and to roll or twist the airbag about the exterior of the rolling fork.

Turning now to Figure 3, an end of one of the rolling forks, 9, is shown to an enlarged scale, but the other rolling fork 10 is of the same design. The rolling fork 9 consists of an inner rotatable element 11 and an outer rotatable element 12. At least one of the rotatable elements is provided with a controllable rotary drive means adapted to rotate the element in a controlled

manner. The other element is mounted either for free rotation, or for driven rotation.

The inner element 11 is shown as a rod provided with the diametrically extending slot 13. The inner element 11 may, however, be tubular, with at least one axial slot in the side wall of the tube. The outer element 12 is a tubular element. The tubular element must have at least one axial slot 14 formed therein, and in the illustrated embodiment two diametrically oppose slots 14 and 15 are provided.

At this stage it is to be understood that if the inner rod 11 and the outer tube 12 are initially located so that the slot 13 in the inner rod 11 is aligned with at least one of the slots 15 provided in the outer element 12. An edge of part of an airbag may be inserted through the slot 14 so that the edge of the airbag is present within the diametric slot 13 provided in the inner element 11. If one or other (or both) of the elements is then driven rotationally, so that there is a relative movement between the inner member 11 and the outer member 12, the edge part of the airbag will be "nipped" between the inner member 11 and the outer member 12. Continuing rotation will cause part of the airbag to be wound onto the combination of the rod 11 and tube 12. The inner rod 11 may be replaced by a small diameter tube.

Turning now to Figure 4, at an initial stage in the folding process for an airbag, such as a driver's airbag for a motor vehicle, the components of the folding table are located so that the upper surface of the plunger 3 is flush with the upper folding surface 2 of the table, the horizontally moveable plungers 4 and 5 are retracted and the covers 7 and 8 are retracted, with the folding forks 9 and 10 in a fully extended position in which they extend into the cavity 6 above the plunger 3.

An airbag 20, which is connected to a conventional airbag housing 21 associated with a gas generator 22, is then located above the cavity 6.

The airbag is held, by appropriate grippers, so that two points 23, 24, which are substantially diametrically opposed points on the airbag, are drawn apart from each other. Consequently the airbag adopts a configuration in which the main inflatable part of the airbag presents two separate tabs 25, 26 (shown most clearly in Figure 5) which depend at slightly spaced apart points beneath the housing 21.

A similar effect may be achieved by supporting the central part of the airbag on a support rod beneath a central part of the airbag and moving the support rod upwardly to support the airbag so as to again provide the effect of two depending tabs. Alternatively again the airbag may simply be positioned on a support rod in the desired configuration.

With the airbag in this condition, the airbag is lowered so that the lowermost end portions 27, 28 of the depending tabs 25, 26 are inserted into the cavity 6, and the very edge portions 27, 28 of the tabs are engaged by the two rolling forks 9 and 10 in the manner described above. The rolling forks 9, 10 are then rotated, with rolling fork 9, as shown in Figure 5, rotating in a clockwise sense and the rolling fork 10, as shown in Figure 5, rotating in an anti-clockwise sense. The two depending tabs are thus wound onto the rolling forks to form two parallel spaced apart rolls 30 and 31. The tabs are thus roll folded outwardly from the centre of the airbag. As the rolls are created so the housing 21 is lowered to be located adjacent to the cavity 6. The rolls have parallel axes coincident with the axes of the rolling forks 9, 10.

The fabric remaining between the rolls at the end of the rolling process is the fabric that will be diametrically opposed to the gas generator when the airbag is inflated.

When the housing 21 is immediately adjacent to the top of the folding table, as shown in Figure 7, 8 the two cover plates 7 and 8 are moved inwardly to cover the cavity 6. The cover plates are moved in to such an extent that the cover plates are in contact with or are almost in contact with the housing 21. The rolls 30, 31 are thus within the substantially sealed cavity then the rolling forks 9, 10 are retracted, by moving the rolling forks axially laterally towards the right as shown in the accompanying drawings. The two rolls 30 and 31 are thus left lying within the cavity 6 without the rolling forks within them.

The horizontally moveable plungers 4 and 5 are then driven inwardly from the initial retracted position towards the centre of the cavity 6. The plungers move in until the leading faces of the plungers are substantially aligned with the outer periphery of the vertically moveable plunger 3. As the plungers move in so the rolls 30, 31 are axially compressed with a scrunching or random folding. This is the situation shown in Figure 10. The compressed airbag has a size and shape equivalent to that of the interior of the housing 21. The folded airbag is then driven upwardly, by vertical movement of the plunger 3, into the housing 21. The plunger may be dimensioned to be inserted slightly into the housing to ensure that the compressed airbag is fully received in the housing. A cover may then be applied to the housing 21, to retain the airbag as the folding operation is complete.

The invention as been described with reference to an embodiment in which two parallel rolls are formed from two depending tabs using rolling

forks. Whilst a special design of rolling fork has been described, simple rolling forks with two prongs may be used.

In an alternative embodiment of the invention, instead of using rolling forks, horizontally moveable folding blades are utilised to effect a zig-zag folding of each depending tab, so that the tabs are folded to form two parallel stacks, with the stacks effectively corresponding with the rolls of the illustrated embodiment. The stacks are received within the cavity in the folding table and are then compressed axially by the horizontally moveable plungers 4 and 5 so that the compressed airbag has a configuration equivalent to that of the interior of the housing.

In the present Specification "comprise" means "includes or consists of" and "comprising" means "including or consisting of".

The features disclosed in the foregoing description, or the following Claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS:

1. A method for folding an airbag comprising steps of taking an airbag secured to an airbag housing dimensioned to receive the airbag when folded, configuring the airbag to have two depending tabs, rolling or folding each of the tabs to form a roll or fold having an axis, the axes being substantially parallel, subsequently compressing the rolled or folded tabs axially so that the compressed airbag has a configuration equivalent to that of the interior of the housing, and then driving the compressed airbag into the housing.
2. A method according to Claim 1 wherein the airbag is held in the initial position by a holding device which holds points on the periphery of the airbag.
3. A method according to Claim 1 wherein the airbag is held in the initial position by means of an elongate support element.
4. A method according to any one of the preceding claims wherein the two depending tabs are rolled in opposed directions, being rolled outwardly from the centre of the airbag.
5. An apparatus for folding an airbag, the apparatus comprising a first arrangement to hold the airbag in a configuration with two depending tabs, the apparatus further comprising a folding table having two parallel rolling or folding mechanisms each adapted to engage one of the said tabs and roll or fold the tab, and a compressing arrangement to compress the rolled or folded tabs thus created, and a driving arrangement adapted to drive the compressed airbag into a housing

6. An apparatus according to Claim 5 wherein the compressing mechanism comprises two horizontally moveable plungers, moveable towards each other above a folding surface of the folding table, the plungers being associated with covers, also moveable towards each other, the covers being moveable to a position in which a cavity is defined between the covers and the table, the plungers being moveable into the cavity.

7. An apparatus according to Claim 5 or 6 wherein the driving arrangement comprises a plunger provided in the table, and moveable vertically from an initial position in which the upper surface of the plunger is flush with the folding surface of the table.

8. An apparatus according to any one of the preceding Claims wherein the table has two rolling mechanisms, each rolling mechanism being in the form of a rolling fork comprising an inner generally cylindrical or tubular element received rotatably within an outer tubular element, the inner element and the outer element each having an axial slot, the elements being movable rotationally relative to each other, and being moveable rotationally together.

9. A rolling fork, the rolling fork comprising an inner generally cylindrical tubular element comprising an inner generally cylindrical or tubular, element received rotatably within an outer tubular element, the inner element and the outer element each having an axial slot, the elements being movable rotationally relative to each other, and being moveable rotationally together.

10. A rolling fork according to Claim 9 wherein one element is freely rotatable and the other element is rotationally driven.

11. A rolling fork according to Claim 9 or 10 wherein the inner element is a slotted rod.
12. A method of folding an airbag substantially herein described with reference to the accompanying drawings.
13. An airbag folded by a method of any one of Claims 1 to 4 or 10.
14. An apparatus for folding an airbag substantially as herein described with reference to and as shown in the accompanying drawing.
15. A rolling fork substantially as herein described with reference to and as shown in the accompanying drawings.
16. Any novel feature or combination of features disclosed herein.



14



INVESTOR IN PEOPLE

Application No: GB 0129420.6
Claims searched: 1 to 15

Examiner: Guy Robinson
Date of search: 21 February 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): B7B (BSBCC, BSBCM)

Int Cl (Ed.7): B60R 21/16, 21/20

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	JP 2001294112 A (HONDA)	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.